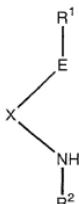


What is claimed is:

1. A composition comprising

(1) a ligand characterized by the following general formula:



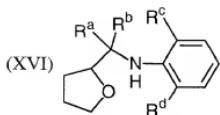
5 wherein,  $E$  is selected from O, S, Se, Te; each  $R^1$  and  $R^2$  is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof;  $X$  is  
10 any covalent bridging moiety provided that  $X$  is not a benzylic bridge where the benzylic carbon atom is bound to the  $NHR^2$  fragment and optionally,  $R^1$  and/or  $R^2$  may joined together with  $X$  in a ring structure;

(2) a metal precursor compound characterized by the general formula  $M(L)_n$  where  $M$  is a metal selected from Groups 3, 4 and the lanthanides;  $L$  is independently

15 selected from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, amino, amine, hydrido, allyl, diene, seleno, phosphino, carboxylates, thio, 1,3-dionates, oxalates, carbonates, nitrates, sulphates, and combinations thereof;  $n$  is 1, 2, 3, 4, 5, 6, 7, 8, or 9; and

(3) optionally, at least one activator;

with the provisio that when  $M$  is zirconium, then the ligand is not a compound according to formula XVI:



wherein each R<sup>a</sup> and R<sup>b</sup> are each independently selected from the group consisting of alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl and hydrogen; and R<sup>c</sup> and R<sup>d</sup> are each independently selected from the group consisting of alkyl, aryl and hydrogen.

5

2. The composition of Claim 1, with the further proviso that M is not zirconium when R<sup>1</sup> and X are joined together in a ring structure.

3. The composition of Claim 1 in which the ligand is not a compound according to structure (IIa) or (IIb), where M' is zirconium.

4. The composition of Claim 1 in which the ligand is not a compound according to structure (IIa) or (IIb).

10 5. The composition of Claim 1 in which the ligand is a compound according to formulae (III), (IV), (V), (VI), (VII), (VIII), (IX) (X) and (XI).

15 6. The composition of Claim 5 in which the metal precursor is substantially pure with respect to the metal.

20 7. The composition of Claim 6 in which the metal is hafnium.

8. A composition comprising a ligand characterized by formula (III), (IV), (V), (VI), (VII), (VIII), (IX), (X) or (XI);

25 a metal precursor compound characterized by the general formula M(L)<sub>n</sub> where M is hafnium; L is independently selected from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, amino,

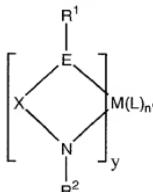
amine, hydrido, allyl, diene, seleno, phosphino, carboxylates, thio, 1,3-dionates, oxalates, carbonates, nitrates, sulphates, and combinations thereof; n is 1, 2, 3, 4, 5, 6, 7, 8, or 9; and

optionally, at least one activator.

5

9. The composition of Claim 8 in which the metal precursor compound is about 90% or more pure with respect to the metal.

10. A metal ligand complex characterized by the following formula:



10 wherein, E is selected from O, S, Se, Te; each R<sup>1</sup> and R<sup>2</sup> is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; X is any covalent bridging moiety provided that X is not a benzylic bridge where the benzylic carbon atom is bound to the NHR<sup>2</sup> fragment; and optionally, R<sup>1</sup> and/or R<sup>2</sup> may be joined together with X in a ring structure; M is a metal selected from Groups 3, 4 and the lanthanides; L is a ligand which is independently selected from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, amino, amine, hydrido, allyl, diene, seleno, phosphino, carboxylates, thio, 1,3-dionates, oxalates, carbonates, nitrates, sulphates, and combinations thereof; n' is 1, 2, 3, 4, 5, 6; and when M is a Group 3 or lanthanide metal, y may be 1 or 2; and

when M is a Group 4 metal, y may be 1, 2, or 3; provided that the metal ligand complex is not a complex according to formula (XXVII) in which M' is zirconium.

11. The metal ligand complex of Claim 10 with the proviso that when E is O and R<sup>1</sup> and X are joined together in a non-aromatic ring structure, then M is other than zirconium.

12. The metal ligand complex of Claim 10 with the proviso that when R<sup>1</sup> and X are joined together in a ring structure, then M is other than zirconium.

10

13. The metal ligand complex of Claim 10 which is not characterized by the formula (XVIII) where M' is zirconium.

14.

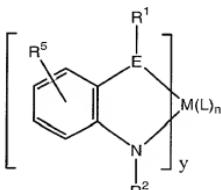
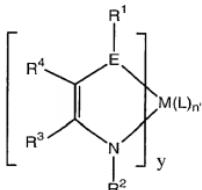
The metal ligand complex of Claim 10 which is characterized by a formula selected from the group consisting of (XIX), (XX), (XXI), (XXX), (XXXI), (XXXII), (XXXIII), (XXXIV) and (XXXV).

20

15. The metal ligand complex of Claim 10 which is substantially pure with respect to the metal.

16. The metal ligand complex of Claim 15 in which the metal is hafnium.

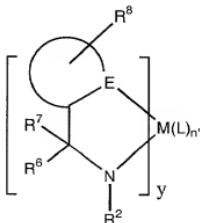
17. A metal ligand complex which is characterized by either of the following formulae:



25

wherein, E is selected from O, S, Se, Te; each R<sup>1</sup> and R<sup>2</sup> is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxyl, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; M is a metal selected from Groups 3, 4 and the lanthanides; and L is independently chosen from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, amino, hydrido, allyl, diene, seleno, phosphino, carboxylates, thio, 1,3-dionates, oxalates, carbonates, nitrates, sulphates, and combinations thereof; y is 1, 2 or 3; and n' is 1, 2, 3, 4, 5, 6.

18. A metal ligand complex characterized by the following formula:

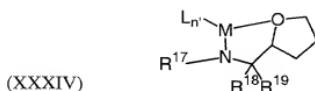


15 where M is hafnium; E is selected from the group consisting of O, S, Se, and Te; y is 1, 2 or 3; n' is 1, 2, 3, 4, 5, 6; R<sup>2</sup>, R<sup>6</sup> and R<sup>7</sup> are each independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxyl, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; and each R<sup>8</sup> is independently selected from the group alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl,

alkoxyl, aryloxyl, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

19. The metal ligand complex of Claim 18 characterized by the following

5 formula:



wherein R<sup>17</sup> is aryl or substituted aryl; R<sup>17</sup> and R<sup>18</sup> are independently hydrogen, alkyl, substituted alkyl or aryl; and M, L and n' are as previously defined.

10

20. A metal ligand complex characterized by a formula selected from the group consisting of (XIX), (XX), (XXI), (XXX), (XXXI), (XXXII), (XXXIII), (XXXIV), and (XXXV) in which M is hafnium.

15

21. The metal ligand complex of Claim 20 which is substantially pure with respect to the hafnium.

22. A polymerization reaction or process employing a composition according to Claim 1.

20

23. A polymerization reaction or process employing a composition according to Claim 2.

24. A polymerization reaction or process employing a composition according to Claim 3.

25

25. A polymerization reaction or process employing a composition according to Claim 4.

26. A polymerization reaction or process employing a composition according to  
Claim 5.

5 27. A polymerization reaction or process employing a composition according to  
Claim 6.

28. A polymerization reaction or process employing a composition according to  
Claim 7.

10

29. A polymerization reaction or process employing a composition according to  
Claim 8.

30. A polymerization reaction or process employing a composition according to  
Claim 9.

15

31 A polymerization reaction or process employing a metal ligand complex  
according to Claim 10.

20

32. A polymerization reaction or process employing a metal ligand complex  
according to Claim 17.

33. A polymerization reaction or process employing a metal ligand complex  
according to Claim 18.

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34. A polymerization reaction or process employing a metal ligand complex  
according to Claim 20.

35. A polymerization reaction or process employing a metal ligand complex  
30 according to Claim 21.

36. The process of any one of Claims 22-35 wherein the at least one activator comprises an ion forming activator and, optionally, a group 13 reagent.

37. The process of any of Claims 22-35 wherein the at least one activator

5 comprises an ion forming activator and, optionally, a divalent reagent.

38. The process of any one of Claims 22-35 wherein the at least one activator comprises an ion forming activator and, optionally, an alkali metal reagent.

<sup>39</sup>

10 40. A process for catalytically polymerizing a monomer comprising subjecting the monomer to polymerization conditions in the presence of a catalyst composition, wherein said catalyst composition comprises a metal ligand complex according to any one of Claims 1, 8, 16-18 and 20.

<sup>40</sup>

15 41. The process of Claim 40 wherein said at least one monomer is an olefin, diolefin or acetylenically unsaturated compound.

<sup>41</sup>

20 42. A process for polymerizing a monomer, comprising providing a reactor, providing at least one monomer to said reactor and providing a composition or catalyst to said reactor, wherein said composition or catalyst is defined as in any one of Claims 1, 8, 16-18 and 20 and subjecting said reactor contents to polymerization conditions.

<sup>42</sup>

25 43. The process of claim 42 wherein said at least one monomer is an olefin, diolefin or acetylenically unsaturated compound.

<sup>43</sup>

44. An array of compounds wherein each compound of the array is different from the other compounds of the array, and there are at least 8 compounds in the array, wherein each of the compounds is characterized by the general formula:



wherein, E is selected from O, S, Se, Te; each R<sup>1</sup> and R<sup>2</sup> is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted

5 cycloalkyl, heteroalkyl, substituted heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; X is any covalent bridging moiety excluding a benzylic bridge where the benzylic carbon atom is bound to the NHR<sup>2</sup> fragment; and optionally, R<sup>1</sup> and/or R<sup>2</sup> may joined  
10 together with X in a ring structure.

45. The array of claim 44, wherein each compound additionally comprises a metal precursor M(L)<sub>n</sub> where M is a transition metal or main group metal or lanthanide metal and L is independently each occurrence selected from the group consisting of

15 halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, cyclopentadienyl, substituted cyclopentadienyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, hydride, thio, seleno, phosphino, amino, amine, carboxylates, 1,3-dionates, oxalates, carbonates, nitrates, sulfates, perchlorates, sulfonates phosphonates and  
20 combinations thereof; and n is an integer from 1-9.